# The future of 3D is glass-free autostereoscopic

*As Avatar director James Cameron put it, for 3D to appeal to the television-viewing audience, the 3D glasses have to go. "That is the point where the curve (of buyers) is going to go ballistic," he said. MAARTEN TOBIAS, CEO of Dimenco, a leader in autostereoscopic 3D technologies, takes stock of the state of A3D developments.*

On 18 December 2009, the world broke into 3D in a big way with the release of *Avatar*, that eventually became the highest grossing movie of all times. Stereoscopic 3D functionality can now be found in all kind of devices – TVs, laptops, game consoles, even mobile phones.

Has 3D changed the playing field of the consumer electronics market? Is the rise of 3D an industry push or a consumer pull? Let's looks at the facts.

## 3D – an industry push

The content industry is certainly the first industry interested to push 3D. With declining box-office revenues, illegal movie downloads, slower-than-expected Blu-ray take-up and online distribution ventures, the advent of 3D enables content publishers to 'rejuvenate' revenue streams by distributing premium-priced material via existing – and new – distribution and delivery channels. While stereoscopic 3D is not new, the digitization of the audio-visual environment has now made it a viable commercial proposition.

The industry has always worked to set new standards, push new technologies and create new markets. With a TV industry operating in an ever fiercer competitive playing field where margins are under pressure and product differentiation ever more difficult to attain, 3D is seen to provide a revenue-generating breathing space. In brief, 3D comes as a shot of adrenalin in the arms of the consumer electronics industry for which HDTV has now become a low-margin commodity.

This is especially true for plasma display panel (PDP) manufacturers who were losing rapidly market share to liquid crystal display (LCD) panel makers. The 3D active shutter glasses technology gives the edge to PDP displays as these can handle the faster refresh rate that 3D requires. Another advantage of PDP is that the active shutter technology is not onerous to integrate; the bill of material amounts to a few dollars.

From the point of view of consumers, however, the active shutter stereoscopic technology may not be a logical step to introduce 3D, as the technology requires wearing 3D glasses, still expensive, heavy, unsightly and incompatible across CE brands.

Also, some users complain 3D active shutter glasses subject them to flickering and interference. This is one reason why passive (polarized) glasses technology are being introduced, which avoid this discomfort and make it more convenient to watch 3D material for longer periods of time. It is also why most post-production houses evaluate 3D using passive and not active technology to look at their content.

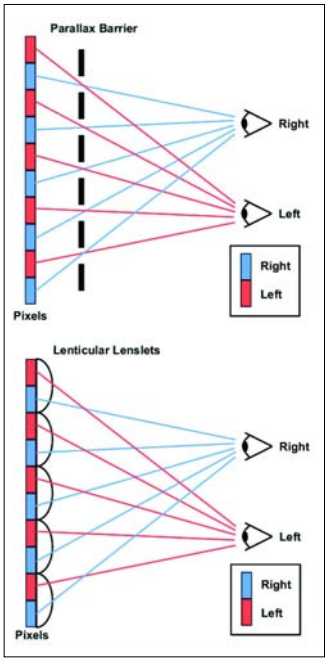
But the late introduction of passive 3D glasses is due to the substantial bill-of-material (BOM) cost that impacts on the supply chain, the developments needed to ensure 2D quality is not lost when watching TV, and last but not least, the inability to offer Full 1080p in each eye, something active shutter glasses provide.

## The consumer decides?

Both the content publishers and the CE industry are pushing 3D helped by a generally positive press that sings the successes of 3D TV with optimistic forecasts. But the question that should be asked is whether 3D is really so successful or are there other reasons for its so-called success?

Let's take a look at the product ranges of the established TV brands in 2011. Most of the high-end, and increasingly mid-range, TV sets nowaday come 3D-ready. As the 3D capability become a feature of low-end products, the 'natural' penetration of 3D in the coming years will further increase. But, do consumers buy a TV because it is 3D-enabled or because they need a new TV that happens to be 3D-ready?

To determine the 'true' success of 3D one ought to look at the sales volumes of 3D glasses and, eventually, 3D Blu-ray disc sales. On both counts, the figures are still disappointing.




*Auto-stereoscopic 3D principles*

The reason, I believe, is that consumers just do not like to sit on their couch with specific glasses to watch TV. It prevents them from engaging in it. While watching TV, many people check their emails, cook, read a newspaper, and, of course, interact with their loved ones. Can you imagine a romantic night with your partner watching a movie, where eye contact is 'mediated' by unsightly glasses? And will you have enough expensive 3D eyewear for all your friends who will come to watch a football game?

As *Avatar* director James Cameron put it, for 3D to appeal to the television-viewing audience, the glasses have to go. "That is the point where the curve (of buyers) is going to go ballistic," he said.

These observations lead me to conclude that 3D is not a consumer pull, but rather an industry push.

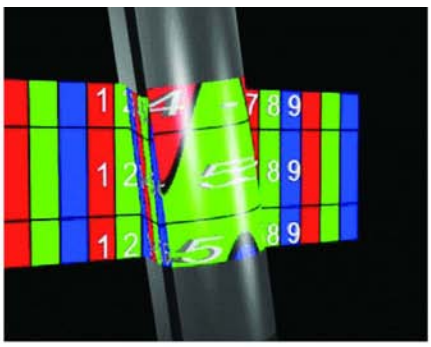
## Towards 3D without glasses

If we believe consumers would like to see 3D without glasses why is it not there yet? To answer this question we have to understand what is the current status of the technology, the challenges and possible applications. 3D without glasses is also known as auto-stereoscopic 3D. Two distinct technologies used by the display industry occupy this field: **parallax barrier** and **lenticular-based** system.

Parallax barrier, is a device placed in front of the LCD panel which consists of a layer of material with a series of precision slits, allowing each eye to see a different set of pixels, so creating a sense of depth through parallax.

Although the parallax barrier approach provides a convincing and immersive 3D image it leads to, at time, questionable image quality as not all pixels are visible owing to the front screen placed on the LCD. Challenges in color distortion, contrast loss, blurriness and loss of brightness are often mentioned. The latter can be solved by using more powerful backlight, but that will contribute significantly to the power consumption.

The reason why the industry has embraced parallax barrier, as currently seen in the Nintendo 3DS, LG Optimus 3D and HTC 3D EVO, is the relative ease to manufacture large scale displays providing convincing 3D effects with low BOM costs. The technology makes it easy to switch between 3D and full-resolution 2D display (more on switchable technology later). Other companies offering LCD displays with this technology are Tridelity, NewSight and Visumotion, mainly targeting the digital signage/professional market.



## Lenticular technology

The other autostereoscopic technology is lenticular-based. This technology relies on lens which zoom in on different groups of pixels when looking from different viewpoints. Thus, each eye sees a different set of pixels. By rendering different images for different viewpoints depth perception is realised without the need for glasses. Keeping the number of viewpoints limited and repeating the sets of viewpoints ensures that loss of resolution is limited while offering a sharp and immersive 3D perception.

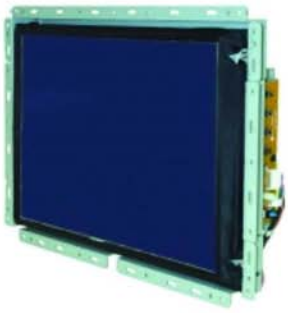
While this approach can suffer, like parallax barrier, from loss of resolution, viewing angle, cone transitions, fixed viewing distance and banding, a lenticular-based system is not challenged by color distortion, contrast or brightness loss.

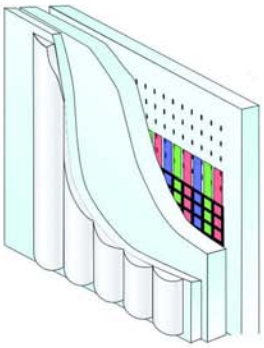
Developments recently made by Dimenco in the area of lenticular designs have resulted in a more controlled loss of horizontal and vertical resolution. They have also allowed control of variation of intensity across viewing angles, resulting in the absence of black stripes (banding) over the display.

Dimenco's developments further allow the user to change the viewing distance dynamically in real-time. The 'cone' transitions are less visible and the viewing angle has increased to 150°. These were all seen as important limitations for a wide-scale introduction of lenticular technology.

At CES this year, TV manufacturers such as Toshiba, Sony and LG, were showing lenticular-based prototypes of their auto-stereoscopic TV sets. These lenticular-based prototypes all used native Quad Full High Definition (QFHD) or 4K (3840 x 2160 pixels) panels. With the lenticular (or parallax) system the number of pixels is divided by the number of viewpoints. That is reason why the 3D image resolution is less than that of the native panel.

It means that if a 'simple' Full High Definition (FHD) panel (1920 x 1080 pixels) is used for auto-stereoscopic 3D, the resulting image might lose about 3 to 4 times the original resolution, depending on the specific lens design, thus offering only a Standard Definition image. So, using a QFHD panel will provide a FHD 3D auto-stereoscopic image. Because the lens is fixed in front of the panel, the 2D image is also compromised and will suffer the same resolution loss.





## Preserving 2D quality

The loss of resolution is the primary reason why auto-stereoscopic lenticular TV displays are not yet on the market. It's therefore no surprise that only a small group of consumers is willing to pay a premium for 3D without glasses while accepting a loss in 2D resolution.

There are two options to solve this issue. The first is the introduction of higher resolution QFHD panel that produce a FHD 2D picture. The displays industry will probably push in this direction as it is continuously looking for ways to add value (pixels) to their products to maintain margins via price premium. 3D auto-stereoscopy could be an incentive for manufacturers to increase volumes of QFHD panels making them price-competitive.

*Multiple camera angle capture*

The other option could be to actively switch the lens. This means that these displays have the unique ability to switch from a full resolution 2D image to a 3D image. This is done by a LC-lens-switch, which switches off the lens on the display when full resolution is needed for an application such as Internet browsing or text. With the LC-lens-switch in 2D mode, all pixels contribute to the native high-resolution image. Dimenco recently showed 22" and 43" switchable prototypes and expects the first commercial products in 2012.

## Conclusion

Most people in the industry say that 3D TV without glasses is still 10 to 15 years away. I am convinced that this will only take about 2 to 3 years before we will see the first commercial auto-stereoscopic 3D TV products. The reasons? Most leading TV manufacturers are actively working on lenticular-based auto-stereoscopic technology. I expect that we will see promising samples at IFA 2011, all based on a QFHD panel.

The implementation of parallax barrier technology in mobile devices will help adoption of 3D without glasses. They will slowly move to lenticular technology, enabling faster developments in switchable technology. Panel makers will push QFHD to be price-competitive enabling them to maintain price levels and push innovation.

But let's keep in mind that the success of glasses-less 3D TV ultimately lies in attractive 3D content!

### BIOGRAPHY

Prior to founding Dimenco, of which he is the CEO, MAARTEN TOBIAS worked at Philips Electronics within the Philips 3D Solutions division where he was responsible for sales and business development for USA, Europe and Russia. Dimenco is focused on glasses-free autostereoscopic 3D display technology and 3D content creation tools. The company is a leader in the A3D field. Contact: maarten@dimenco.eu